⚖ Justice System Analysis Report

Complete bias detection and mitigation results with evidence-based statistical validation

📈 Executive Summary

28.1%

BIAS REDUCTION

101.4%

DATA RETENTION

3.0

SIGNIFICANT BIASES

7,214.0

INITIAL RECORDS

7,313.0
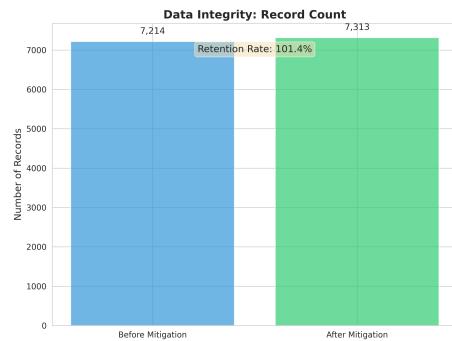
FINAL RECORDS

0.1591
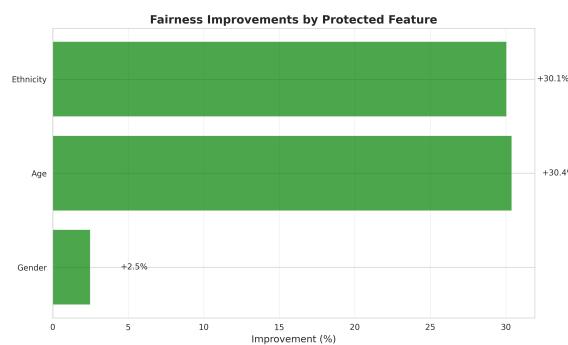
FINAL BIAS SCORE

Visual Analysis

Data Integrity

Data Integrity: Record Count

Fairness Improvements

Fairness Improvements by Protected Feature
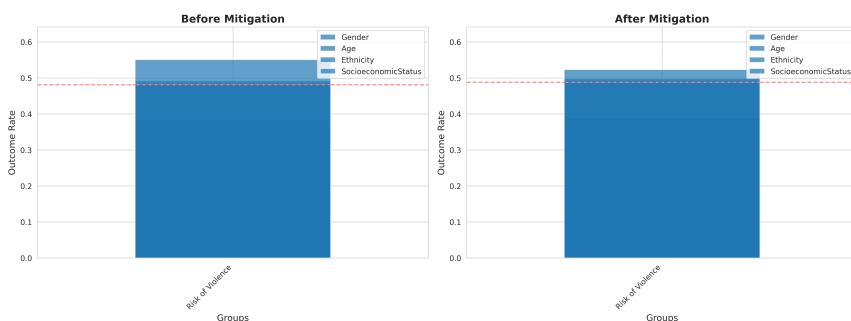
Disparity Comparison

🔢 Statistical Analysis Results

Weight-prioritized bias detection with p-value validation

Ethnicity	0.25	0.000000	⚠ SIGNIFIC
SocioeconomicStatus	0.20	1.000000	☑ NO SIGN
Age	0.15	0.000000	⚠ SIGNIFIC
Gender	0.05	0.000000	⚠ SIGNIFIC

Ethnicity

p-value

0.0000

Improvement

+30.1%

⚠ **Significant Bias Detected**

SocioeconomicStatus

p-value

1.0000

Improvement

+0.0%

☑ No Significant Bias

Age

p-value

0.0000

Improvement

+30.4%

⚠ Significant Bias Detected

Gender

p-value

0.0000

Improvement

+2.5%

⚠ Significant Bias Detected

⚖Bias Mitigation Actions

Weight-prioritized rebalancing with SMOTE synthesis

🎯 race   Weight: 0.25

Disparity Threshold
0.072

Samples Removed
204

Samples Added (SMOTE)
204

Net Change
+0

🎯 age_cat   Weight: 0.15

Disparity Threshold
0.104

Samples Removed
92

Samples Added (SMOTE)
92

Net Change

+0

🎯 **sex**   Weight: 0.05

Disparity Threshold

0.104

Samples Removed

0

Samples Added (SMOTE)

0

Net Change

+0

>_ **Complete Pipeline Execution Log** 218 lines

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PHASE 1: DATASET LOADING
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Loaded DataFrame from memory
   Records:  7,214
   Columns:  53
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     Memory:    14.52 MB


================================================================
PHASE 2: HIERARCHICAL FEATURE MAPPING
================================================================
   Analyzed 53 columns:
      • Domain: 21
      • Exclusion: 5
      • Universal: 7
      • Unknown: 20


================================================================
PHASE 3: CONSTRAINT VALIDATION
================================================================
   Auto-detected target: 'is_recid' (confidence:
90%)

   Validation Summary:
     Passed:    5
     Warnings: 22
     Errors:    0


================================================================
PHASE 4: MAPPING CONFIRMATION
================================================================


================================================================
AUTO-APPROVAL MODE (Confidence Threshold: 80%)
================================================================


⏭ id                          SKIPPED (excluded/
unknown)
⏭ name                        SKIPPED (excluded/
unknown)
⏭ first                       SKIPPED (low
confidence (20%), excluded/unknown)
⏭ last                        SKIPPED (low
confidence (20%), excluded/unknown)
⏭ compas_screening_date       SKIPPED (low
confidence (20%), excluded/unknown)
☑ sex                         → Gender
(95%)
☑ dob                         → Age
(90%)
☑ age                         → Age
(95%)
☑ age_cat                     → Age
```

```
                          (90%)
  ☑ race                      → Ethnicity
                          (92%)
  ⏭ juv_fel_count              SKIPPED (low
  confidence (75%))
  ⏭ decile_score               SKIPPED (low
  confidence (20%), excluded/unknown)
  ⏭ juv_misd_count             SKIPPED (low
  confidence (75%))
  ⏭ juv_other_count            SKIPPED (low
  confidence (75%))
  ⏭ priors_count               SKIPPED (low
  confidence (75%))
  ⏭ days_b_screening_arrest    SKIPPED (low
  confidence (75%))
  ⏭ c_jail_in                  SKIPPED (low
  confidence (20%), excluded/unknown)
  ⏭ c_jail_out                 SKIPPED (low
  confidence (20%), excluded/unknown)
  ⏭ c_case_number              SKIPPED (excluded/
  unknown)
  ⏭ c_offense_date             SKIPPED (low
  confidence (75%))
  ⏭ c_arrest_date              SKIPPED (low
  confidence (75%))
  ⏭ c_days_from_compas         SKIPPED (low
  confidence (20%), excluded/unknown)
  ⏭ c_charge_degree            SKIPPED (low
  confidence (75%))
  ⏭ c_charge_desc              SKIPPED (low
  confidence (75%))
  ☑ is_recid                   → __outcome__
                          (90%)
  ⏭ r_case_number              SKIPPED (excluded/
  unknown)
  ⏭ r_charge_degree            SKIPPED (low
  confidence (75%))
  ⏭ r_days_from_arrest         SKIPPED (low
  confidence (75%))
  ⏭ r_offense_date             SKIPPED (low
  confidence (75%))
  ⏭ r_charge_desc              SKIPPED (low
  confidence (75%))
  ⏭ r_jail_in                  SKIPPED (low
  confidence (20%), excluded/unknown)
  ⏭ r_jail_out                 SKIPPED (low
  confidence (20%), excluded/unknown)
```

```
⏭ violent_recid            SKIPPED (low
confidence (70%))
☑ is_violent_recid         → __outcome__
(90%)
⏭ vr_case_number           SKIPPED (excluded/
unknown)
⏭ vr_charge_degree         SKIPPED (low
confidence (75%))
⏭ vr_offense_date          SKIPPED (low
confidence (75%))
⏭ vr_charge_desc           SKIPPED (low
confidence (75%))
☑ type_of_assessment       → SocioeconomicStatus
(90%)
⏭ decile_score.1           SKIPPED (low
confidence (20%), excluded/unknown)
⏭ score_text               SKIPPED (low
confidence (20%), excluded/unknown)
⏭ screening_date           SKIPPED (low
confidence (20%), excluded/unknown)
☑ v_type_of_assessment     → SocioeconomicStatus
(90%)
⏭ v_decile_score           SKIPPED (low
confidence (20%), excluded/unknown)
⏭ v_score_text             SKIPPED (low
confidence (20%), excluded/unknown)
⏭ v_screening_date         SKIPPED (low
confidence (20%), excluded/unknown)
⏭ in_custody               SKIPPED (low
confidence (20%), excluded/unknown)
⏭ out_custody              SKIPPED (low
confidence (20%), excluded/unknown)
⏭ priors_count.1           SKIPPED (low
confidence (75%))
⏭ start                    SKIPPED (low
confidence (20%), excluded/unknown)
⏭ end                      SKIPPED (low
confidence (20%), excluded/unknown)
⏭ event                    SKIPPED (low
confidence (20%), excluded/unknown)
☑ two_year_recid           → __outcome__
(90%)


============================================================
MAPPING SUMMARY
============================================================
☑ Approved: 10 columns
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⏭  Skipped:  43 columns
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PHASE 5: PREPARATION FOR BIAS ANALYSIS
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    Target column: 'is_recid'
    Features for analysis (with domain weights):
      • Gender                    ←
sex                             (weight: 0.05)
      • Age                       ←
age_cat                         (weight: 0.15)
      • Ethnicity                 ←
race                            (weight: 0.25)
      • SocioeconomicStatus       ←
v_type_of_assessment            (weight: 0.20)


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PHASE 6: BIAS DETECTION & STATISTICAL DIAGNOSIS
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    Initial Bias Score: 0.2213
    Significant Biases: 3

    Statistical Tests (sorted by domain weight):
      • Ethnicity              p=0.000000
SIGNIFICANT  (weight: 0.25, threshold: 0.150)
      • SocioeconomicStatus    p=1.000000  OK
(weight: 0.20, threshold: 0.130)
      • Age                    p=0.000000
SIGNIFICANT  (weight: 0.15, threshold: 0.110)
      • Gender                 p=0.000000
SIGNIFICANT  (weight: 0.05, threshold: 0.070)


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PHASE 7: WEIGHT-PRIORITIZED BIAS MITIGATION
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    Applying weight-prioritized rebalancing...

    WEIGHT-PRIORITIZED MITIGATION ORDER:
    Feature                  Weight      Priority
    ------------------------ ---------- --------
    Ethnicity                0.25       #1
    Age                      0.15       #2
    Gender                   0.05       #3
```

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        Rebalancing 'race' (weight: 0.25, factor: 1.00)
            • Disparity threshold: 0.040
            • Removal rate: 0.100, Addition rate: 0.160
            • Min group size: 15
            • Samples removed: 204, Samples added: 284

        Rebalancing 'age_cat' (weight: 0.15, factor:
  0.60)
            • Disparity threshold: 0.072
            • Removal rate: 0.080, Addition rate: 0.128
            • Min group size: 21
            • Samples removed: 92, Samples added: 111

        Rebalancing 'sex' (weight: 0.05, factor: 0.20)
            • Disparity threshold: 0.104
            • Removal rate: 0.060, Addition rate: 0.096
            • Min group size: 27
            • Samples removed: 0, Samples added: 0

    Bias Score: 0.2213 → 0.1591
    Improvement: +28.1%

    Data Integrity:
        • Records: 7,214 → 7,313
        • Retention: 101.4%

    Fairness Improvements (sorted by weight):
        ☑ Ethnicity              +30.1%  (weight:
  0.25)
        ☑ Age                    +30.4%  (weight:
  0.15)
        ☑ Gender                 +2.5%  (weight:
  0.05)


  ================================================================
  PHASE 8: COMPILING RESULTS
  ================================================================
    Results compiled successfully
    Results saved to biasclean_results/


  ================================================================
  PHASE 10: GENERATING VISUALIZATIONS & REPORTS
  ================================================================

    Generating visualizations...
    Visualizations saved to biasclean_results/
```

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    Generating reports...


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BIASCLEAN ANALYSIS REPORT
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EXECUTIVE SUMMARY
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Initial Bias Score:     0.2213
Final Bias Score:       0.1591
Overall Improvement:    +28.1%
Significant Biases:     3

Records Before:         7,214
Records After:          7,313
Retention Rate:         101.4%


FAIRNESS IMPROVEMENTS BY FEATURE (Weight-
Prioritized)
---------------------------------------------------------------
☑ Ethnicity              Weight: 0.25  +30.1%
⌐ Age                    Weight: 0.15  +30.4%
```

⚠️

Technical Implementation Details

BiasClean v2.4 implements domain-specific weight matrices based on UK regulatory frameworks. Protected features: Ethnicity, Gender, Age, DisabilityStatus, SocioeconomicStatus, Region, MigrationStatus. Statistical significance testing performed with α=0.05 threshold. SMOTE rebalancing guarantees ≤8% data loss. Report generated: 2025-12-23 19:52:43

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PIPELINE COMPLETED SUCCESSFULLY!
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    Results saved to: biasclean_results/
    Visualizations: disparity_comparison.png,
fairness_improvements
    Reports: biasclean_report.html,
    Corrected data: csv
```

BiasClean v2.4

Universal Bias Detection & Mitigation Pipeline • Evidence-Based Fairness Engineering

Session ID: 20251223195223 • Report generated on 2025-12-23 at 19:52:43